

## ORIGINAL RESEARCH

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# Why USB-endoscope laryngoscopy is as effective as video laryngoscopy

## Abstract

**Purpose:** To compare the efficacy of a low-cost custom-made universal serial bus (USB) endoscope laryngoscope for intubation with a direct laryngoscope and a high-cost video laryngoscope in a mannequin study.

**Methods:** We used one intubation simulator model (mannequin) in our study. A USB endoscope was mounted to the direct laryngoscope as a custom-made USB endoscope laryngoscope (USB-L). We used a video laryngoscope (Glidescope®, Verathon, USA) and a direct laryngoscope (Macintosh) for comparison. Intubation time and the correct placement of the tube were measured. Intubations were performed by two operators and results were compared.

**Results:** We found a statistically significant difference between the video and direct laryngoscope groups ( $p < 0.001$ ), as well as between the USB-L and direct laryngoscope groups ( $p = 0.001$ ) for Operator 1. For Operator 2, there was a statistically significant difference between the video laryngoscope group and the direct laryngoscope group ( $p = 0.022$ ); however, we did not find a significant difference between the USB-L group and the direct laryngoscope group ( $p = 0.154$ ). Furthermore, there were no significant differences between the USB-L and video laryngoscope groups for either operator ( $p=0.347$  for Operator 1 and  $p>0.999$  for Operator 2).

**Conclusion:** Our study showed that USB endoscope laryngoscope provided similar intubation time to video laryngoscopy at a fraction of the cost; and both had superior times in comparison with direct laryngoscopy.

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## Introduction

Endotracheal intubation is one of the major interventions for airway management in the emergency department [1]. Various methods can be used to check whether the intubation tube is in the trachea: thorax auscultation, capnography, ultrasonography, video laryngoscopy and fiberoptic bronchoscopy are the most common methods in daily practice [2-4]. Of these common methods, video laryngoscopy is available commercially from several companies. Video laryngoscopy is also used by emergency physicians, especially in tertiary emergency departments.

Previous studies have shown that video laryngoscopy reduces the frequency of erroneous esophageal intubation [3]; however, expense precludes the widespread use of this technique [5]. There are several reports on the use of custom-made video laryngoscopes in airway management, which are made by simply attaching universal serial bus (USB) endoscope cameras to conventional direct laryngoscopes. Muhamed et al. showed that intubations performed with a custom-made video laryngoscope (USB-L) were performed in a shorter time period than intubations with a conventional (Macintosh) direct laryngoscope [6]. Karippacheril et al. also demonstrated that USB-L was useful in verifying tracheal intubation [7]. In a cadaver study, Sanri et al. found that the sensitivity and specificity of tracheal ultrasound and USB-L were the same (both 100% accurate), when confirming endotracheal tube placement [8].

In this study, we compared the efficacy of an inexpensive (\$8.50 USD) custom-made USB-L with both a direct laryngoscope and a high-cost video laryngoscope for intubation in a mannequin study.

## Materials and methods

We conducted our study after gaining the approval of the Baskent University Medical and Health Sciences Research Committee. We used one specific intubation simulator model (mannequin) (TruCorp, Armagh, N. Ireland) in our study (Figure 1). Using the simulator, we were able to change the level of difficulty of the laryngeal exposure, but our model lacked virtual reality and haptic feedback. For a USB endoscope, we used an inexpensive (\$8.50 USD) waterproof light endoscope with a 5 mm cable length and a 5 mm diameter, with 480 p and 0.3 MP resolution, which can be easily integrated into a smartphone (Android Camera™, China). The USB endoscope was mounted to the Macintosh laryngoscope to setup a USB-L using an adhesive band, as shown in Figure 2. We used a video laryngoscope (Glidescope®, Verathon, USA) and a direct laryngoscope (Macintosh) for comparison with the USB-L.

Intubation procedures were performed by two emergency medicine specialists, each with at least five years of experience. Intubations were performed by these two operators to observe any differences between individuals. We changed the operator and the order and method of intubation and we allowed for some time between each attempt. We used an endotracheal tube with a diameter of 7 mm.

The intubation time began as soon as the laryngoscope entered through the mouth of the model and ended when the operator indicated that the tube had settled. We then evaluated the placement of the tube: a third senior emergency medicine specialist confirmed the accuracy of the tube's location.

In the preliminary biostatistics evaluation, we found that to properly compare the intubation time and correct placement of the tube for the three devices, 159 intubations were required for 80% test power and a 95% confidence level. Thus, each operator performed 27 intubations on the model using each of the three devices. All statistical analyses were performed using IBM SPSS v25. We evaluated the distribution of continuous variables according to the Kolmogorov-Smirnov test. Since parametric test

**FIGURE 1. TruCorp intubation simulator model used in the study.**



**FIGURE 2. The set-up of USB endoscope laryngoscope.**

We integrated a 5 mm cable length, 5 mm diameter waterproof light USB endoscope with 480 p and 0.3 megapixel resolution into a smartphone (Android Camera™, China). We mounted the USB-endoscope to the Macintosh laryngoscope using an adhesive band.

assumptions were not provided in the study, we gave the numerical measurements as median (minimum-maximum) and categorical data as frequency (n) and percentage (%). We analyzed the differences between the devices in terms of numerical measurements according to the Kruskal-Wallis test. We then evaluated the differences between the groups using the Dunn-Bonferroni test with multiple comparison tests and created box plot graphs. We analyzed the Mann-Whitney U test for similarities between the two operators regarding the intubation times from each device. In the analysis, we determined the probability of type I error as 0.05.

## Results

First, we examined whether there was a difference between the two operators' intubation times. We did not find any statistically significant difference between the duration of the intubations performed using direct laryngoscopy, video laryngoscopy or USB-L ( $p = 0.703$ ,  $p = 0.071$  and  $p = 0.153$ , respectively).

There was a statistically significant difference between the device groups in terms of the intubation times of both Operator 1 and Operator 2 ( $p < 0.001$ ,  $p = 0.022$ , respectively) (Table 1). We used the Dunn-Bonferroni test

with multiple comparison tests to determine which device groups differed. A statistically significant difference was found between the video laryngoscope group and the direct laryngoscope group, as well as between the USB-L group and the direct laryngoscope group for Operator 1 ( $p < 0.001$ ,  $p = 0.001$ , respectively). However, there was no significant difference between video laryngoscope group versus USB-L group ( $p = 0.347$ ) (Figure 3). For Operator 2, there was a statistically significant difference between the video laryngoscope group and the direct laryngoscope group ( $p = 0.022$ ). We did not find a significant difference between the USB-L group and the direct laryngoscope group ( $p = 0.154$ ), and video laryngoscope group versus USB-L group for Operator 2 ( $p > 0.999$ ) (Figure 4). For all attempts, the placement of the tube was correct.

## Discussion

Taking advantage of the opportunities provided by technology to facilitate endotracheal intubation, one of the basic emergency interventions, provides additional comfort for emergency physicians. The cost of devices such as video laryngoscope and fiber-optic laryngoscope is very high; therefore, we aimed to encourage the use of a low-cost method such as USB-L, which could potentially benefit emergency physicians especially in regions with limited resources. We compared the efficiency of USB-L with direct laryngoscopy and high-cost video laryngoscopy using a simulator (mannequin). Our results showed that, in experienced hands, low-cost USB-L is as effective as video laryngoscopy in terms of intubation time and correct localization of the tube.

Karippacheril et al. showed that the average total intubation time with USB-L was  $28.58 \pm 21.01$  seconds (9–89 seconds). Karippacheril and colleagues managed to intubate three patients with difficult intubations at the first attempt and suggested that the use of USB-L was safe [9]. Jungbauer et al. showed that video laryngoscopy was statistically significantly superior to direct laryngoscopy in terms of its glottic imaging, success rate and intubation time in the difficult intubation of 200 patients.

**TABLE 1. Comparison of intubation times of devices for each operator**

Operator	Comparison of intubation times*				Multiple comparison		
	Direct laryngoscope <sup>1</sup> n=27	Video laryngoscope <sup>2</sup> n=27	USB-L <sup>3</sup> n=27	<i>p</i>			
Operator 1	7.07(3.79-25.06)	4.09(2.21-11.20)	4.84(3.39-10.34)	<b>&lt;0.001†</b>	1	2	<b>&lt;0.001</b>
						3	<b>0.001</b>
					2	3	0.347
Operator 2	7.21(3.19-15.78)	4.58(2.67-15.05)	5.03(3.77-13.40)	<b>0.022†</b>	1	2	<b>0.022</b>
						3	0.154
					2	3	>0.999

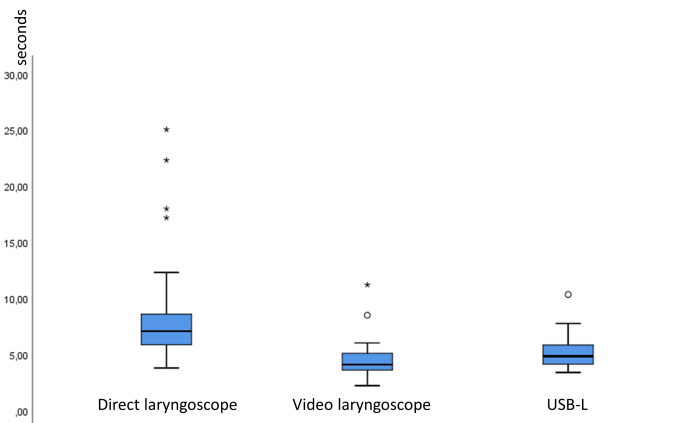
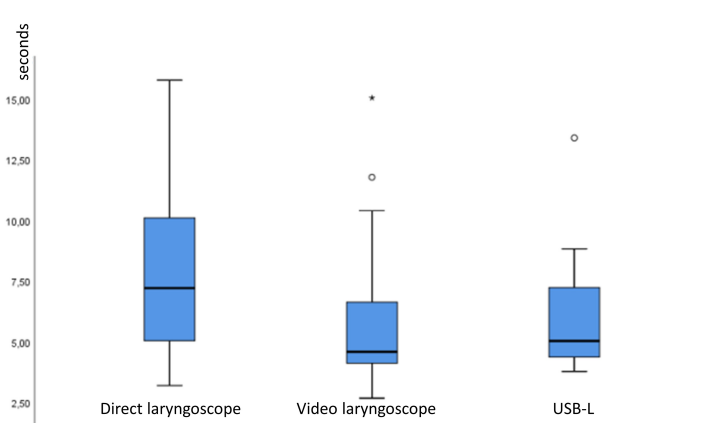
\* According to the results of the Dunn-Bonferroni multiple comparison test, the differences between the groups are indicated by the numbering.

† Kruskal-Wallis test; median (minimum-maximum)

In a clinical study, Vadhanan et al. compared USB-L with direct laryngoscopy and reported that the mean intubation time was shorter for USB-L; however, no statistically significant difference was found [14]. In a letter to the editor, Hasija et al. suggested that USB-L provides similar views and clarity as well as ease of intubation; comparable to video laryngoscopy [15].

#### Limitations

We evaluated the intubation time, despite the ambiguity as to whether intubation time was truly the best measure as newer technology can be more cumbersome at the beginning. Both video laryngoscopy and USB-L were found to be superior to direct laryngoscopy in terms of intubation times; however, in some trials, we encountered difficulty in inserting and advancing the intubation tube, and these issues may be related to prolonged intubation times.

**FIGURE 3. Intubation times of Operator 1.****FIGURE 4. Intubation times of Operator 2.**

## Conclusions

In conclusion, we compared USB-L with direct laryngoscopy and video laryngoscopy, which we regard as the gold standard. Our study showed that low-cost USB-L provided similar intubation time to video laryngoscopy; both had superior times to direct laryngoscopy. Additionally, with USB-L we obtained similar views to those obtained with the video laryngoscope in glottic visualization. However, there were attempts in which we had difficulty inserting and advancing the intubation tube.

Although there is some ambiguity in the literature regarding the superiority of video laryngoscopy over direct laryngoscopy, the former clearly helps the physician in such areas as glottic imaging and decreased esophageal intubations. However, the high cost is an important constraint for hospitals with insufficient facilities and for pre-hospital emergency medical services. We believe that USB-L will prove useful under these conditions, and for educational purposes, and warrants future innovation investment.

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